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ABSTRACT

Practitioners involved in implementing technology education in middle, junior, and senior high schools should keep several guiding principles in mind. Technology education is a vital educational component in a highly technological society, and present and future societies will depend upon the wise use of technology as an important factor in survival and human progress. Technology education must be packaged and delivered in keeping with the characteristics and needs of all students at all ability levels. The program should be experientially based and should utilize the base of research findings on how individuals learn. Instruction should take place in the context of a multi- and cross-disciplinary involvement of the learner. Technology education must be extended beyond the craft domination of previous years and most programs, thus making technology education much more broadly conceived than technical education as it is usually understood. The process of technology education must be a holistic one that recognizes the fact that nothing can be studied to any measurable degree within a single discipline. (MN)

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IMPLEMENTING TECHNOLOGY EDUCATION IN AMERICA'S SCHOOLS

by

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The general theme of this session -- "implementing technology education in America's schools," is a matter of prime importance, as well as dire urgency, for the profession. The importance of implementation grows out of the need for the industrial arts/technology education profession to demonstrate that it can, in fact, implement a viable form of technological education in keeping with the needs of citizens in the present and future societies. The dire urgency emanates from a certain degree of impatience in the educational and lay communities with the traditional emphases in industrial arts. This has been evidenced by the numerous commission reports (though not mentioned by name), the new high school graduation requirements springing up all over the country, and the numerous other attractive electives available to high school students as they pursue their studies.

The "implementing" issue is important to the profession for it is through actual demonstrated performance that the area of technology education will establish itself as a viable and vital component of the broader educational community. The changing of names or titles of programs or courses, the numerous speeches on the virtues of technology education, and the endless number of articles espousing technology education have little impact on the decision-makers in our local, state and national educational establishments. What is needed is a form of implementation that turns kids and parents on to what is happening in their technology education laboratories. It is the un-

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abashed excitement of young people at all levels of ability in and out of the laboratories, as well as in their homes and communities, that will cause the decision-makers to sit up and take notice. Without such educational implimentations, the concept of technology education remains in the province of convention meetings, professional journals, and the hard or soft covered textbooks.

There are a few guiding principles that I would suggest for background consideration as we proceed into the implementation dimension of technology education. These principles would include:

1. Technology education is a vital educational component in a highly technological society.

This point is supported by the following comment from the publication, Educating Americans for the 21st Century. (NSF, 1983)

> People must know about technology in order to improve the quality of many personal and professional technology-based decisions.
>
> Technological literacy prepares individuals for intelligent participation as informed citizens in the transition from an industrialized society to a post-industrialized service and information age.
>
> Technological literacy will encourage greater participation by individuals in shaping public policy, which often involves the use of sophisticated technology. It will tend to encourage civic responsibility and overcome voter torpidity, which can arise out of a lack of understanding of new technologies. (p. 74)

2. Present and future societies will depend upon the wise use of, as well as wise decisions about, technology as an important factor in survival and human progress.

With respect to this principle, the publication, Educating Americans for the 21st Century, (NSF, 1983) contains the following statement:

> People must understand the limitations as well as the capabilities of emerging technologies. The technologically literate person should have a sense of what technology can and cannot do. He or she should not believe that technology can solve all ills, nor that technology is responsible for most problems. (p. 74)

3. Technology education must be packaged and delivered in keeping with the characteristics and needs of all students at all ability levels.

All of the students in our public schools will live in an advanced technological society that will be characterized by change and increased complexity. More and more of the issues dealing with human survival and the quality of life will depend upon wise decisions regarding the use of, and decisions about, technology. Thus, if our democracy is to survive in the future technological society, it will require new levels of technological literacy on the part of all citizens.

Boyer (1983) in his book, The High School, linked an understanding of science and technology to the issue of technological literacy.

> We live in a complex, dangerous and fascinating world. Science has played a role in creating the dangers, and one hopes that it will aid in creating ways of dealing with these dangers. But most of these problems cannot, and will not, be dealt with by scientists alone. We need all the help we can get, and this help has got to come from a scientifically literate general public. Ignorance of science and technology is becoming the ultimate self-indulgent luxury. (p. 25)

4. Technology education must be an experientially based (laboratory hands-on) program that utilizes the best of research findings in how the individual learns.

Experiential and first-handed education has been a major strength of Industrial Arts. It is a vital element that must remain and be strengthened as the transition to technology education takes place. The nature of projects and activities will change, but the level of student involvement will increase as the constructional, design, and manipulative activities also include analyses and syntheses related to social and environmental impacts, long-range implications, etc.

5. Technology education must be taught in the context of a multi-disciplinary and cross-disciplinary involvement of the learner if

understanding as well as functional literacy with technological issues or concepts are to be accomplished.

The publication, A Nation at Risk, (1983) addresses this principle from a literacy point of view in the following statement:

> . . . Knowledge of the humanities. . . . must be harnessed to science and technology if the latter are to remain creative and humane, just as the humanities need to be informed by science and technology if they are to remain relevant in the human condition . . . (p. 10)

In addition to the very important literacy dimension, there is the important concept that if technology is to be understood, it must be in the context of a multi-disciplinary involvement on the part of the student. This will involve science, mathematics, social studies, economics, history, communications and geography.

Another vital component in the advocacy for a multi-disciplinary approach is the fact that a good experiential involvement in technology education can provide the students with opportunities to see and get involved in the applications of science, mathematics, communications and numerous other disciplines.

6. There must be a broadened perspective about the nature of technology education that would extend it beyond the craft domination of previous years and most programs. This would also imply that technology education would be much more broadly conceived than what one would call technical education.

The implementation of this principle will be one of considerable challenge and concern for many in the field of Industrial Arts as there is the movement to Technology Education. The dominance of craft related activities has limited both the breadth of content as well as the school population participation once the program became an elective in the student's program.

If technology education is perceived in any degree of breadth with respect to understanding technology, as well as its use and societal-environmental

impacts, it will assume new dimensions of content, new dimensions of acceptability, and new dimensions of the school population it will serve.

7. Technology education must be conceived and implemented in a holistic process that recognizes the fact that nothing can be studied to any measurable degree within a single discipline.

The absence of subject matter integration has been a hallmark of our educational processes. There must be someplace, some area in the school where the student can put it all together. This principle, if implemented to any degree, would cause the school to function in new and dynamic ways. Instead of the school operating as a series of disjointed subjects with rigid walls separating them, there would be a certain magnetic flux centered around the study of technology education toward which each of the relevant disciplines would be drawn. The flux of relevancy that exists in each of the disciplines with respect to its contribution to technology education would indeed provide for a new dimension of schooling and educational practice.

It would indeed make the school program a living, dynamic organism rather than a collection of dismembered parts of a body that had not been put together.

8. As a final principle in this listing, I would persist in reminding the profession that the over-riding goal of our educational system is the development of people -- the fulfillment of people, and the achievement of the promise in each.

Technology education has a major role to play in achieving that national goal. It is a goal that is fundamental to the over-riding function of education in a democracy. It is a goal that places value and worth on each individual.

It is a dream and a hope for education where we can have it both ways. We can have strong, valid technology education at the same time we are having a strong, valid emphasis on the development of the individual. The strength

and vitality of a technological society that is anchored in the processes of citizen involvement demands it. Furthermore, the future technological achievements, the acceptance of such achievements, and the wise use of such achievements will require both effective technology education and the maximum development of each individual.

The preceding principles related to the implementation of technology education serve as guidelines to the process of developing programs for the middle, junior and senior high schools.

The next step in the process is to project or establish specific goals toward which technology education should be directed. There have been numerous suggested focus for such objectives or goals. One foci has been in the direction of understanding individual technologies as entities in themselves. Such an effort would put considerable emphasis on developing a greater understanding of the mathematics and scientific principles involved in the makeup and/or function of a given technology. This particular emphasis would be supported by a number of statements in recent national reports.

The publication, Educating Americans for the 21st Century (Source Materials) (NSF, 1983), contains the following statements.

> Technological literacy is the possession of a reasonable understanding of the behavior of technological systems and requires knowledge of scientific and mathematical concepts. . . . (p. 74)
>
> . . . The mathematics and science education now offered to your young people could be greatly enriched if we were to incorporate a technological content. (p. 73)

The publication, A Nation at Risk, by the National Commission on Excellence in Education (1983) emphasized the importance of science technology education in a comment attributed to Paul Hurd, as follows:

> We are raising a new generation of Americans that is scientifically and technologically illiterate. (p. 10)

The experiential involvement of the student with technological artifacts, systems or entities must go beyond the mere making of a class project or

constructional unit; it must involve a greater thrust in the direction of understanding, which may be enhanced significantly by knowledge of the scientific and mathematical principles involved.

A second dimension of understanding deals with such elements as "social impact" and "environmental impact" of the technology. This direction was emphasized in a conversation with Dr. Ernest L. Boyer, in which he stressed the need to go beyond mathematical and science applications and to move into the realm of social and environmental implications. This particular emphasis extends the implementation beyond the technical into a broader base of understanding closely associated with the role of the citizen in a democratic society. It grows out of a concern for technological impact on two of this planet's most precious commodities, i.e., the human component and the environment upon which the human and all living species depend for their quality of life. Both of these items are valid dimensions of technology education that can be integrated into an experiential involvement with a broad range of technologies. These two aspects of technology education make important contributions to the general education emphasis of this area of study.

It is clear that the incorporation of understandings in the areas of mathematics, science, social impact and environmental concepts provide an important and valid base for implementation of the programs in technology education. Furthermore, there are experiential models already in existence that can demonstrate their implementation potential.

A second focus that the profession may want to take deals with an emphasis on technological literacy. This direction likewise has enormous potential for implementation on a broad interdisciplinary base.

Of course, technological literacy includes understandings associated with mathematics, science, etc. However, the emphasis on technological literacy

is more directly pointed toward the needs of citizens as functioning participants in the democratic processes in a society such as ours.

One statement that focuses in this direction is contained in the National Science Foundation publication, Educating Citizens for the 21st Century, (Source Materials), (1983).

> Contributing to technological literacy is an understanding of: (1) the historical role of technology in human development, (2) the relationship between technological decisions and human values, (3) the benefits and risks of choosing technologies, (4) the changes occurring in current technology, and (5) an understanding of technology assessment as a method for influencing the choice of future technologies. (p. 74)

There are some relationships between these five elements and the previously listed factors of math, science, social impact and environmental impact. These will be brought out in the ensuing discussion of each of the above points.

1. The understanding of "the historical role of technology in human development" provides the profession with a rich opportunity to demonstrate its capability in this area.

Implementation. The anthropological unit approach to technology education as contained in The Maryland Plan (1973) is a direct and proven implementation. The students select and pursue the study of a technological development (loom, cotton gin, trebuchet, Newcomen steam engine, waterwheel, windmill, turbine, catapult, etc.) This study involves library, museum, mail, and phone inquiry into the background of the technological item selected by the student. The student constructs a model of the item he/she has selected to pursue. The student also writes a report which contains, among other elements, such dimensions as a historical presentation of the item, scientific factors involved and social impacts.

The monograph, Math/Science/Technology Projects, (AIAA, 1985) contains examples of fourteen such anthropological projects with photographs and

listings of mathematics and science principles as well as social and environmental impact listings. These items, as previously stated, are examples and do not constitute a program.

2. The understanding of "the relationship between technological decisions and human values" is an area that has rich potential for implementation in technology education.

Implementation. Student activities in this area could center around community and city planning dealing with such technologies as transportation systems, housing accommodations, trash and waste disposal, communications systems and energy sources. Other projects could center around hydro-electric developments, airport and transportation center developments, mining and mineral extraction technologies, mining in the ocean, pollution control measures, etc. Each of these would involve construction activities, student inquiry, interdisciplinary involvement, seminars, as well as written and oral reports.

3. The third area identified for technological literacy deals with an understanding of "the benefits and risks of choosing technologies."

Implementation. This area of technological literacy can be effectively implemented through a broad range of student inquiry and construction activities associated with energy development, transportation systems, water supply, housing, pollution, trash and waste disposal, communications and manufacturing processes. Each of the above has numerous alternatives that present varying kinds of risks to humans as well as the environment. Each of the alternatives has potential for exciting, interesting and challenging constructional activities. The processes for inquiry into the various technologies extend into the library, governmental agencies, private industry, community agencies, scientific and professional associations.

4. The fourth area deals with an understanding of "the changes occurring

in current technology."

Implementation. This is an excellent area of understanding that may be addressed through programs involving robots that are programmable, computer controlled robots, computer assisted drafting, computer assisted manufacturing, computer graphics, fiber optics in communications, laser beam technology, energy development technology, composite materials technology, quality control advancements and techniques, construction technologies, and a broad range of transportation technologies. It is quite obvious that as the student pursues the advancements in these areas, the experiential involvement will differ substantially over the previously craft-dominated activities.

5. The fifth area deals with that very important dimension of "technology assessment as a method for influencing the choice of future technologies." Technology assessment involves the sensitivity, as well as capability, of making appropriate or effective judgments regarding technologies -- current and future. It is a process of analytically examining the merit and/or lack of merit in a given technology for a particular purpose.

Implementation. This dimension of technological literacy can be implemented by a wide variety of experiential involvement on the part of the student. As an example: the field of energy development is one in which the processes of technological assessment can be very effectively pursued. Such assessment may be carried out on a particular facet of energy development. The gasification of coal is such a unit within the spectrum of energy development technologies. An analytical study can be made of this unit that would deal with such factors as economics, pollution, efficiency, environmental impact, social impact, short and long range consequences, employment, technological dependencies, state and federal regulations, international trade, interstate transportation and economics, dependent industries, etc. There also is the issue of trade-

offs involved in moving forward with such a technology.

The preceding example was with respect to a single technological energy development unit or component. Assessment analyses may also be made among a variety of technologies in a given area. Such an assessment in the area of energy development technology would include analyses between such technologies as a solar power, wind generators, wave generators, fossil fuel electro-generator, gassification of coal, water power, deep ocean currents, fusion atomic energy, fission atomic energy, trash fuel consumption, etc. The same assessment elements previously mentioned may be used when making comparison assessments on any of the alternative technologies in a given field.

Other important areas beyond energy development technologies might include those in the fields of communications, water development, pollution control, housing, transportation, trash and waste disposal, construction, and manufacturing. All of these have alternatives within their respective fields.

Of course, since the process of technological assessment, if it is to have any meaning or significance, must be done with a concern for the future. Humankind has the potential for designing and developing the kind of a future that is wanted or desired. The bigger question that must precede the actual task of technological assessment is -- What kind of a world or society does humankind want? If this question is not dealt with seriously and thoroughly, all is but an academic exercise or a fruitless game.

The task of implementing a program of technological literacy that is to contribute to technological literacy over the broad spectrum of students in our schools, must assume a dimension of breadth, challenge and composition that will, in fact, be of value to all. This means a new emphasis, a new content, and a new commitment to the concept of general education for technology education.

Implementation will be the key dimension of our activity. The focus and

directions of that implementation demands a perspective that reaches out into the future and the needs of our citizens in that future.

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